

Extracted from the Annual Report of the Fisheries Research Board of Canada 1957-58, Ottawa 1958.

ARCTIC UNIT, MONTREAL, QUE.

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The Arctic Unit of the Fisheries Research Board is located in premises leased from McGill University, at 505 Pine Ave. West, Montreal. Library privileges of the University and of the nearby Arctic Institute of North America are extended to the staff, and make available for research a large body of literature dealing with northern biology and oceanography. Close contact with the Arctic Institute, and with the staff and students of various University departments, for example those of Zoology and Geography whose work is strongly slanted towards the North, has proved to be of mutual advantage.

The Unit at present operates no permanent field stations. Seasonal base camps are established at various locations throughout the Northwest Territories. Work is organized along three broad lines: fishery investigations, marine mammal investigations and biological oceanography. The Unit's main research vessel, M.V. *Calanus*, was prevented by excessively heavy ice conditions from leaving Rowley Island, Foxe Basin, where she had been hauled up for the winter in late 1956. She was used as living quarters and a field laboratory by a party which carried out oceanographic and fishery studies at Rowley Island.

FISHERIES INVESTIGATIONS

Fisheries work in the Arctic to date has been largely of a survey nature to establish relative abundance, life-history, seasonal movements and utilization of the various species. Special research projects are expected to develop as fishing becomes more organized and intensive. In the meantime, exploratory work is of great importance in the light of the need to divert hunting pressure from the decreasing stocks of barren-ground caribou to other undeveloped or underutilized resources.

FIRTH RIVER, YUKON. Gill-net fishing at the mouth of the river was carried out, in cooperation with the Royal Canadian Mounted Police, from June 7 to 20, before the break-up of sea-ice. This supplemented the fish sampling of 1956 in this locality, which was hampered by bad weather. The main species taken were arctic char and lake herring. Analysis of data and material taken is still in process.

MACKENZIE RIVER. During the summer a survey was carried out along the river from Aklavik to Fort Norman, to gather information on abundance and utilization of fishes. Travel was by a small launch, and the party of two men carried out experimental fishing along the route, interrogated residents and gathered available statistics. The requirement of fish by residents of the area covered was estimated at 3.5 million fish per year, which confirms earlier estimates. The actual

catch probably is less than this, since a fair amount of food is imported, including prepared dog food.

An awareness of the need for fisheries statistics has been created in responsible people of the region, and a set of catch statistics was received for 1957 by the Department of Northern Affairs and National Resources.

A fair portion of the catch comes from winter lake-fishing, while river and tributary fishing is concentrated at times of fish migration. Many of the stocks apparently escape utilization. The catch of whitefish, crooked-back whitefish, and lake herring in the Delta region is mainly of old, large fish that have completed or nearly completed their growth. There is no evidence anywhere as yet of overfishing. Increased fishing effort in fact should produce a higher sustained yield.

COPPERMINE RIVER. Sampling of fish began in late June as soon as the ice went out. Arctic char is the main fishery at this time. Three movements of char were evident: a down-stream migration immediately upon break-up, a second in mid July and an up-stream migration in late August and early September. There is evidence of a segregation of those fish which will spawn in the current year, from the others. Char that will spawn in a given year were caught only in the feeder-lakes, and not in migrating stocks.

The major bulk of other species caught were whitefish, crooked-back whitefish, lake herring, suckers and lake trout. Analysis of whitefish ages has demonstrated a large range of variation in growth. Individual fishes all show regular growth to about 11 years, with a sudden increase in rate over the next two or three years. Little growth is exhibited after this burst, though the fish live for at least 20 years. Variable growth possibly can be attributed to the river mouth stocks being made up from several populations originating in different tributaries and headwaters. The spurt of growth after the eleventh year may be a result of migration to the sea or to the warmer river water.

Crooked-back whitefish do not show the spurt of growth in late life that common whitefish do, and fish older than 13 years were not found.

ROWLEY ISLAND (FOXES BASIN). A study of the char stocks in the river system emptying into Frustration Bay on the northwest end was carried out from May to early September. Over 1,500 specimens ranging from the first year up were caught, measured and sampled by the *Calanus* party. Tagging of char at the mouth of the river is providing information on the movements of the stock. As at Coppermine, it was apparent that fish due to spawn in that year were segregated from the migrating stocks sampled.

MARINE MAMMAL INVESTIGATIONS

Studies on marine mammals are extended south on the Atlantic coast to take in problems formerly worked on from St. Andrews and St. John's. The most intensive fisheries at the present time are those for pothead or pilot whales in Newfoundland, and for harp seals. The latter is an international fishery which takes place both in the Gulf of St. Lawrence and off the east coast of Labrador and Newfoundland. Analysis of the present exploitation of harp seals and its

effect on the stocks is being continued up to date. No further report is yet available as the most recent abundant material is in process of collection or of analysis.

In the Arctic, work was concentrated during the past year on two pinnipeds, walrus and ringed seals, which are of considerable economic importance in the northern marine living economy.

PILOT WHALE AND SQUID OCCURRENCE IN NEWFOUNDLAND, IN RELATION TO WATER TEMPERATURES. Pilot whale distribution is closely correlated with that of the main food, squid. Abundance of squid (*Illex illecebrosus*) in Newfoundland fluctuates markedly. Failure of squid to enter inshore waters results also in failure of the pilot whale hunting. Some evidence of direct short-term correlation between water temperatures and squid abundance over the last 15 years or so has led to an examination of squid and pilot whale abundance in relation to hydrographic conditions. Low squid catches in 1957 followed a cold winter and a drop in water temperature. Early disappearance of pilot whales in the fall of 1957 is interpreted as a movement away due to hydrographical conditions inimical to the squid. It is hoped to continue research along this line with a year-to-year forecast of squid and pilot whale abundance or scarcity as a practical goal.

BIOLOGY OF PILOT WHALES IN NEWFOUNDLAND. Studies in 1957 aimed at resampling the stock from commercial "drives" to determine the effect of the great intensification of hunting since the last investigations in 1954 on biological characteristics of the population. In addition, a survey of the extent of distribution around Newfoundland was made from ship and aerial observations.

A comparison since 1951 of data on pregnancy rate, birth rate, herd size, growth and mortality showed no evidence of severe reduction of the stock. Pilot whales in the summer of 1957 were abundant in localized areas on the east coast of Newfoundland, and "reservoir" stocks existed on the Grand Bank and on the southwest coast of the island. Their comparatively early disappearance is mentioned above.

POTENTIAL SUSTAINED YIELD OF PILOT WHALES. In 1956, a tentative comparison was made of relative numbers and biomasses of large rorquals and pilot whales, from which, with knowledge of the potential yield of large rorquals and data on fertility and natural mortality, a permissible limit of 15,000 was suggested for the catch of pilot whales. Improved field identifications of rorquals in 1957 has led to an upward revision of this number calculated on the same basis. The estimate is still regarded as tentative, pending more observations on relative numbers of different species of whales in Newfoundland coastal waters, over the adjacent banks and over deep water.

BIOLOGY OF MINKE WHALES IN NEWFOUNDLAND. A fishery for this small rorqual has taken 15-60 animals per year in Trinity and Conception Bays between May and August. During the work on pilot whales, the opportunity was taken to make detailed examinations of 17 whales from the catch, which complemented less complete data taken during the period 1952-1954. Adults and animals older than one year predominate in the catch. It has not been possible to demonstrate significant differences in body proportions from larger samples which have been measured in north European seas. There is no evidence of gross geographical

segregation of the sexes in adults such as has been demonstrated in Norway and Japan. In summer these whales move into the coastal region, ranging as far north as Hudson Strait. Winter distribution extends south to the mid States and occasionally to southern Florida, with some individuals apparently remaining in Newfoundland latitudes. The wax ear-plug, recently found to be successful for aging blue and fin whales, is so small that it disintegrates unless obtained fresh, and then only very few show readable laminations. The baleen plates wear rapidly and are not suitable for aging. The conclusions of other workers that maturity in both sexes occurs normally in the third year is supported from analysis of length frequencies and stages of maturity. The food in eastern Newfoundland in early summer is mainly capelin with some cod. Crustacea, herring, salmon and squid are taken to a small degree before and after the capelin season when few whales are present. A full report is in preparation.

WALRUS INVESTIGATIONS. Continued research on cementum layers on tusks and molariform teeth of females indicates reliable aging up to 10 or 12 years. Successful aging for males was reported upon in 1956. Sexual maturity of the female is probably attained at 7 years, with full breeding maturity in the following year.

It has been possible to demonstrate that adult male walrus from northern Foxe Basin average slightly larger than those from Southampton Island. This, plus limited observations on distribution, suggests that the populations are relatively isolated. Counts of walrus from M.V. *Calanus* indicate a population of about 3,000 for northern Hudson Bay. This agrees with an aerial survey of hauling-out grounds in this area in 1954 by the Canadian Wildlife Service. Present knowledge of stock size, mortality and reproductive potential suggests that the northern Hudson Bay stock is well utilized. No increase in annual take is advisable without further careful aerial survey and collection of samples for age composition. It has not been possible yet to estimate the size of the northern Foxe Basin stock. Reproduction data indicate that this stock has a greater reproductive potential and is immune from over-hunting at the present level of utilization. A full report on the biology of the walrus has been completed.

NUMBERS AND AVAILABILITY OF RINGED SEALS. Interest in organized native exploitation of the pinniped resources in the Arctic by the Department of Northern Affairs and National Resources led during the year to studies on populations, availability and economics of the ringed seal, the most important seal in the Arctic, to form a basis both for rational utilization, and regulation by the Department of Fisheries. Biological studies have been completed and are published or in press.

The distribution and abundance of ringed seals is governed by the amount and quality of fast ice on the coastlines inhabited by this seal, and indirectly by the complexity of the coastline. Using actual careful counts made of seals on known areas of ice of representative types and coastlines as a basis, figures have been derived for the numbers of ringed seals inhabiting coastlines throughout the eastern Canadian Arctic, from planimetric measurements of fast ice areas on topographic sheets. At present this has been confined to the eastern Arctic between Pond Inlet on Baffin Island, and Port Harrison in eastern Hudson Bay. Seal

populations range from an estimated 74,900 in the Home Bay area, Baffin Island, to 5,000 for the southwest coast of Hudson Strait, with maximum sustainable annual yields (based on reproductive rates, sex ratios, total mortality and hunting mortality) of 5,990 and 400, respectively. The most important area economically at present is Frobisher Bay, with an estimated stock of 52,700 seals and a potential maximum sustainable yield of 4,210.

Indices of availability have been constructed, based on population figures and areas of fast ice and water in which these populations are dispersed. Utilizing the known results of 40 summer hunts, 16 floe-edge hunts and 19 fast-ice hunts in widely separated arctic localities, these indices have been converted to potential catch per unit of effort, to serve as a guide in development of hunting projects. In addition, since there is a large and important geographical variation in size, tables have been drawn up setting out weights of meat per seal in various seasons and localities. Seasonal variations in salinity of sea water and in blubber amount and specific gravity have been studied to produce tables setting out a loss factor from sinking, in terms of the time of year and latitude. Hunting methods are being surveyed to clarify merits and drawbacks.

BIOLOGICAL OCEANOGRAPHY

Hydrographic, plankton and other invertebrate studies which had been planned for Foxe Basin and its southern outlets had to be postponed because of the heavy ice conditions which affected all shipping in this region in 1957. Collections were made of benthos, plankton and physical oceanographic data, for the most part at a fixed station, from the M.V. *Calanus* at Rowley Island throughout the summer season. Through the cooperation of the Atlantic Oceanographic Group, collections of plankton were obtained during the H.M.C.S. *Labrador* cruise, chiefly from the region north and west of Baffin Island. A special study was made at Ogak Lake, a salt water lake at the head of Ney Harbour, Frobisher Bay, to round off preliminary work reported on in the 1952 published Annual Report. A start was made also on writing up of data on cod in relation to hydrographic conditions at Port Burwell, Hudson Strait, which will be continued in 1958.

OCEANOGRAPHY AT ROWLEY ISLAND, FOXE BASIN. Observations on water temperature, salinity, dissolved oxygen and inorganic phosphate, and collections of plankton were made between late May and September in Frustration Bay, Rowley Island. Depths of stations, taken for the most part through ice cover, were from 9 to 34 metres.

Probably because of the almost constant presence of ice, the summer increase in temperature was very slight and of short duration. In late May, temperatures at all depths were below -1.5°C ., little warmer than during winter. Surface temperatures rose to 1.0°C . in late July, during a very brief freedom from ice. Below 1 metre, however, temperatures remained below 0°C . Return of pack ice in late July was followed by a lowering of surface temperature, to below -1.0°C . in mid August. It is unlikely there was any subsequent increase, since September showed lowering trends.

the rate is higher than in cod of southern Labrador. Tagging was carried out, and preliminary results suggest a population of about 4,000 fish over 30 cm. in length. Much analysis on the lake study has yet to be done.

Landlocked char (*Salvelinus*) were collected from a small freshwater lake discharging into Ogak Lake. Limnological studies, including plankton and bottom fauna collections, were made to provide a background of productivity for the char collections.

INVERTEBRATE STUDIES AND HYDROGRAPHY

FOXES BASIN. The motor vessel *Calanus* wintered in 1955-56 at Igloodik, with two men aboard who carried out biological and hydrographic studies. The vessel was unable to break free of winter ice until the last day of July, 1956. Particular attention then was given to walrus studies, but collection of hydrographic, plankton and bottom samples was carried out. Hydrographic sections were run across Fury and Hecla Strait, and between Jens Munk and Koch, Koch and Rowley, Koch and Baffin, Baffin and Bray, and Bray and Rowley Islands. Water temperature, salinity, oxygen and phosphate values were determined. One station was occupied 28 times throughout a 12-month period. An analysis is now being made of the physical, chemical and biological annual cycle in northern Foxe Basin from this work. One of the most notable features of the Foxe Basin marine cycle is the lateness in the season of the time of maximum production. A phosphate peak in spring and early summer, and a zooplankton maximum in late September represent a cycle several months later than in marine areas of the temperate region. The production of life, although late in the season and of comparatively brief duration, is great.

BIOLOGY OF A PELAGIC AMPHIPOD. An intensive study of *Themisto libellula* which is an important part of the food of ringed and harp seals and arctic char, has been completed. The work includes a review of relevant work on the relation between temperature, metabolism and growth in aquatic organisms. *Themisto* has a two-year life cycle, at least twice as long as the life-time of pelagic Crustacea of similar body size in temperate waters. Breeding is most intense from March to early June, but another breeding season appears to begin in September-October and may continue all winter. Maturation here appears to be associated with decreasing rather than increasing temperature.

HYDROGRAPHY OF THE CALANUS EXPEDITIONS, 1949-54. Working up of the hydrographic data of these expeditions, involving the southern part of the eastern arctic, was continued as a special laboratory project. Particular points of interest to date are: (1) At the 50-metre level (below the influence of surface warming and cooling, and freshening) the water of Hudson Bay and western Hudson Strait is about 0.5°C. colder than that of Ungava Bay. At the 100-metre level there is greater spread of temperatures in Ungava Bay, the Hudson Bay water at this depth being normally below -1°C. even in August. (2) Temperatures in Frobisher Bay are of the same order as those of Ungava Bay but show considerably less spread to the warmer side. Ungava Bay waters thus are less stable than those of Frobisher Bay and much less stable than those of Hudson Bay. (3) The higher stability in the surface layers of Hudson Bay causes the surface temperature to rise several degrees above the levels normal for the rest of the eastern Arctic (up to 10°C., compared to 5.8°C. in Ungava Bay, 4.5°C. in Frobisher Bay). (4) An upturn in the lower ends of the temperature-salinity correlation curves, characteristic for Ungava Bay at the 200-metre level, indicates intrusion of West Greenland water containing an Atlantic element.

Extract from the Annual Report of the Fisheries Research Board of Canada 1956-57, Ottawa 1957.

ARCTIC UNIT, MONTREAL, QUE.

The primary objectives of the Arctic Unit are to assess the marine resources of the arctic regions in the light of present utilization, and to carry out detailed biological studies on species of special importance either directly to the living economy or to the general productivity of the region. Marine mammal studies are extended south on the Atlantic side to include whaling and sealing problems in the Maritimes and Newfoundland area. Late in the year, responsibility for liaison with the Department of Fisheries regarding seal control on the east coast was transferred to the Unit from the St. Andrews Station.

Liaison is maintained with the Department of Northern Affairs and National Resources regarding investigations touching on the role of marine resources in the human living economy. The dependence of many native groups on non-marine wildlife, as well as on marine animals, calls for occasional joint planning with that Department, which is responsible for such wildlife through the Canadian Wildlife Service. Liaison is maintained also with the Atlantic Oceanographic Group at St. Andrews, so that hydrographic work carried out by the Unit can fit as closely as possible into their arctic program. In addition, collection of biological material from arctic cruises of H.M.C.S. *Labrador* is arranged through this group.

FISHERIES INVESTIGATIONS

MACKENZIE DELTA. Work in fisheries for the past two seasons has been concentrated in the region of the Mackenzie River Delta, N.W.T., between Herschel Island and Tuktoyaktuk. Fishes in this area, especially the anadromous species, are relatively abundant. Here especially are possibilities of greater utilization and increased efficiency in fishing methods.

Boat facilities for work in the Mackenzie Delta have been very limited to date: the Board's own boats are an outboard launch and a dinghy. We are working very closely with the Royal Canadian Mounted Police in this area, however, and have been able to pool much of our fishing effort to mutual advantage.

Shore-based fishing operations by the investigators began at Whitefish Station, just west of Tuktoyaktuk, on July 7 and were carried on continuously to September 15. Fishing was carried out at the mouth of the Firth River, opposite Herschel Island, from July 27 to August 10, and at King Point Harbour, just east of this, from August 12 to August 30. Gear used for the most part consisted of gill-nets, though a small trawl was tried off the Firth River, and beach seines and several types of traps were used for collecting.

At Whitefish Station, 10,000 fish of 15 species were taken by the research crew. The majority were of the whitefish family, Coregonidae. At the mouth of the Firth River, coregonids and arctic char made up the bulk of a sample of 1,000 fish of 7 species. The arctic cod *Eleginus gracilis*, an important food fish in the Soviet arctic but unused in Canada, also was taken off the Firth River mouth.

Extracted from the Annual Report of the Fisheries Research Board of Canada 1955, Ottawa 1957.

ARCTIC UNIT, MONTREAL, QUE.

The growth of interest and activity in Canada's northland has increased significantly the Board's responsibilities in Arctic affairs. With the opening up of Arctic areas proceeding at an ever increasing rate, we are faced with the fact that much is unknown about the marine resources of the tremendous region involved. Although the area is vast, it is continuous and there is a close similarity of problems, the most immediate of which concern the human living economy.

The slow growth and reproduction of marine life existing in Arctic waters preclude possibilities of sustained commercial yields as large as those obtained in our more southern waters. Marine mammal stocks on the whole are well utilized, perhaps over-utilized in some areas, but there is room for considerable increase in utilization of fishery resources, chiefly on a subsistence basis. This involves increased fishing effort and improvements in catching methods and in treatment of the catch.

The program in fisheries calls for surveys to see what species are present, exploration for estimates of abundance, life-history and tagging work, as well as studies of the present extent and methods of catching and utilization. It also calls for the identification and study of large amounts of plankton, and benthonic and littoral fauna being collected from the *Calanus* and other field parties, and from H.M.C.S. *Labrador*. The data from such marine biological work must be related to fishery, marine mammal and general oceanographic data in order to understand the factors governing the distribution, movements and abundance of fishes and marine mammals in the Arctic.

The program on marine mammals calls for a study of their utilization, the age compositions of kills by species and area to follow changes in age composition of the stock, tagging to determine movements, studies on the reproductive biology to determine the annual increment and potential harvest based on a sustained yield, the formation of a basis for regulation of the international harp seal fishery, and the study of Atlantic coast whaling problems.

Working space for the arctic investigations of the Board to date¹ has been provided without charge at the Montreal headquarters of the Arctic Institute of North America, through McGill University. The Institute has allowed full access to their facilities. The assistance and co-operation of both bodies are greatly appreciated. McGill University now has extended library privileges to the Arctic Unit. This tremendous assistance to our work, provided through Mr. R. Pennington, McGill Librarian, is gratefully acknowledged.

Laboratory space for work on white whales at Churchill, Manitoba, was provided by the Defence Research Board at its Northern Laboratory, through the laboratory director, Mr. A. M. Pennie.

¹Growth of the Unit's work necessitated arrangements, completed by the end of the year, for increased accommodation in rented space at 505 Pine Ave., Montreal.

"CALANUS" OPERATIONS

Upon completion of her refit, the *Calanus* left Montreal on June 30 and arrived at Coral Harbour, Southampton Island, on August 14. Progress up the Labrador coast was hindered considerably by unusually late and heavy drift ice conditions, chiefly in the region of Nain where the ship was held up for 10 days. Miscellaneous collections were made during all stops. The delay required a cancellation of plans to carry out general biological and marine mammal work in the area of the Belcher Islands, Hudson Bay. Instead the *Calanus* was used almost exclusively in walrus investigations in northern Hudson Bay. Co-operation was extended to A. W. Mansfield of the Arctic Institute and McGill University who earlier had begun walrus studies around Southampton Island. Walrus studies were carried out at Bencas Island, Coats Island, and eastern Southampton Island. The *Calanus* returned to Coral Harbour on August 24 to make ready for the trip to the wintering site at Igloolik.

The ship left Coral Harbour on September 4, and after stops at Repulse, Cape Wilson, Cape Germain, Parry Bay, and Jens Munk Island, arrived at Igloolik on September 22. Most of these stops were made because of bad weather and ice conditions. Slow going in ice at one point used up much fuel and the vessel was re-fuelled by H.M.C.S. *Labrador* off Parry Bay on September 16. The *Calanus* was frozen in safely in a protected bay at Igloolik toward mid-October, and winter work on the marine resources of northern Foxe Basin was started. In the interim between arrival and freezing in, important collections of seals were made. Two men are remaining with the *Calanus* until the autumn of 1956. An Eskimo family is camped by the ship for the winter, and sledging trips will be made to study the wintering areas of the walrus in Foxe Basin, and marine resources in general of the area. Hydrographic data will be collected.

FISHERIES AND MARINE BIOLOGY

WESTERN ARCTIC. A beginning of the study of western Arctic waters was made, with the aim of answering pertinent questions posed by the native food problem. General marine biological information was collected.

Specific questions confronting this study are:

- (1) Are there enough fish available to fill the needs of the local population without depleting this essential resource?
- (2) Where can fish be caught at any given time of year?
- (3) Does a fishery of near commercial dimensions exist anywhere offshore, near enough to be utilized either by present fishing methods or by a small-scale commercial fleet?

The program this year occupied from June 13 to September 26. Exploratory work and observations were made from vessels owned by the Department of Northern Affairs and Natural Resources, the Roman Catholic Mission, the Royal Canadian Mounted Police, by a chartered Indian boat, and by chartered aircraft. Some transportation and all fishing effort were conducted from a 20-foot canoe equipped with 15-h.p. outboard motor. The staffs of the above noted organizations gave valuable advice and assistance.

The most common method of fishing is by gill-net. Some jigging and netting is carried on through holes cut in ice, and sweep nets are used by some on certain species of fish. An estimate of the present utilization in the coastal region of the Mackenzie Delta and upriver to Great Slave Lake is 3,000,000 fish annually. This catch is composed of several species with whitefish (*Coregonus*), inconnu (*Stenodus*) and lake herring (*Leucichthys*) being the most important fishes.

The fresh water of the Mackenzie River strongly influences most of the coastal areas investigated. Freshwater and anadromous fishes of the same species as in the river persisted along the coast toward Tuktoyaktuk. As yet wholly marine species have not been investigated. Small flatfish are caught in the shallow inshore waters. At present they are taken incidentally to capture of other species. No strictly marine fishery exists in the western Arctic. Arctic char, apart from a few caught around Herschel Island, is not an important fish in this region.

Although only a limited amount of study has been done, it appears that more fish could be taken, possibly a doubling of the present catch, without creating an over-fishing problem. Local interviews might lead one to believe that fishes have declined, but diary records of the Roman Catholic Mission at Arctic Red River give a generally stable picture of fish catches since 1890. An investigation into the possibility of an offshore marine fishery for flatfish appears worth while. A change in present technique and methods of capture probably would be helpful.

Collections of data and material were made from three different areas. Approximately 200 specimens of 19 species of fishes were collected for study. In addition, scale samples, length measurements, parasites and stomach contents were collected and are at present under study.

PLANKTON STUDIES. A study of the breeding cycle, growth rate, production and distribution of the important pelagic amphipod *Themisto libellula* was begun and is continuing, using much material collected in past *Calanus* expeditions.

Ecological aspects of phytoplankton production in Hudson Bay, based on 1953 and 1954 collections by the *Calanus*, were studied, using the quantitative sedimentation method supported by qualitative data. Material and data were obtained from surface, 10-, 25-, 50- and 100-metre samples for temperature, salinity, oxygen and quantitative phytoplankton, taken from July to September. The greatest heterogeneous phytoplankton populations were found in the mouth of Hudson Bay. The amplitude of temperature and salinity from ice conditions and surface drift results in a smaller production in surface layers. The most productive layer is in more stabilized conditions at 10 metres. Considerable quantities of phytoplankton in supersaturated water (O₂) are still found at 25 metres, indicating favourable light conditions for photosynthesis. The higher production in the mouth of the bay compared to the bay proper, in spite of the lower temperature in the former, results probably from the nutrient supply from mixing water masses originating in various geographic areas. The taxonomic composition of phytoplankton in the main shows great similarity to that on both sides of the Atlantic.

Preparation of a full report on the physical and chemical oceanographic results of the *Calanus* work since 1949 is nearing completion.

MARINE MAMMALS

WHITE WHALE. Work on white whales was carried out from the site of the commercial fishery for this species at Churchill, Manitoba, from June 14 to September 9. Local sea travel was by freighter canoe and outboard, and a 26-foot whaleboat with inboard. Native people and personnel of the Royal Canadian Navy, Royal Canadian Mounted Police, and the National Harbours Board assisted greatly from time to time.

Biological examination was carried out on 200 white whales. Previous conclusions from Board study pointing to the mating time as May to July were confirmed. Samples of teeth were collected for age composition study. Mr. J. Morphy, Fisheries Officer, was accompanied on July 25 on an aerial survey flight north of Churchill for 40 miles. In this area 2,700 white whales were counted, 900 in the Churchill River estuary and 1,800 near the mouth of the Seal River. By August 30, whales apparently were clear of estuaries and on migration. Further aerial survey is planned and reports from all seasons are being sought from the Royal Canadian Mounted Police and Arctic airline companies.

Bottom dredging to determine available food species for the whales was carried out. A mark which lodges within the blubber and leaves an attached disc outside the skin was developed, to be fired from a crossbow. There was no opportunity for proper marking attempts, which are planned next season.

Twenty-seven white whales were examined in the Mackenzie Delta area of the western Arctic. Further work is planned there next year.

WALRUS. During the walrus studies conducted from the *Calanus*, 32 walrus were tagged on Bencas Island on August 18, out of 150 seen there. Seahorse Point on southeast Southampton Island was visited on August 21. Sixteen were marked here out of 300 seen. A marked reduction in walrus numbers seen at established hauling-out sites compared to 1954 may be attributed to unusually bad summer weather and a remarkable lack of ice in late summer and early fall. Large herds at Seahorse Point, a favoured hunting area, were infrequent this year. Increased hunting in the Bencas Island—Coats Island area probably led to a greater than usual disturbance. The fall catch was correspondingly low.

Further tagging is planned, with some changes in present tagging techniques and plans, indicated by experience to date.

RINGED SEAL. Work on the 1954 ringed seal data and material was completed. During the *Calanus* work in northern Foxe Basin before freezing in, 75 seals were collected for examination. This sample will be compared to the southwest Baffin Island material reported upon last year. Field data suggest that feeding, movement and distribution conform to the patterns found in Baffin Island. Collections from Herschel Island in the western Arctic, Eureka in Ellesmere Island, and Southampton Island, made by co-operating bodies, are available for analysis. Laboratory work on all this material is in progress.

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Interest in increased utilization of Canadian arctic marine and freshwater resources, particularly in sports fishing and hunting, is developing fast. Organized fishing and marine mammal hunting projects designed to benefit certain native groups are under development. The need for basic knowledge on fish and marine mammal stocks and growth rates throughout the arctic is urgent. The Arctic Unit, operating from its headquarters at 505 Pine Avenue West, Montreal, continued to accumulate information on these points with widely distributed surveys, and began a specialized study on char stocks in Frobisher Bay, Baffin Island, where a small commercial fishery has been established.

The research vessel M.V. *Calanus* was launched from Rowley Island, Foxe Basin, where she had been beached for two winters. She was sailed south to a winter berth at Moosonee, Ont., carrying out hydrographic observations and briefly surveying the Ottawa, Sleepers and Belcher Island groups as a basis for 1959 investigations.

By the end of March 1959 construction was well advanced on a new 38-foot experimental fishing vessel for the Western Arctic, M.V. *Salvelinus*. This is expected to be launched late in May, and to be shipped to Aklavik, N.W.T., in the summer of 1959.

FISHERIES INVESTIGATIONS

Fish studies in the main continued to concentrate on general surveys for basic information on abundance and distribution. A specialized project was started on production of arctic char from a single water system supporting an organized fishery. Transportation complications delayed delivery of much material from the surveys to the south, so that detailed analysis on much of it has yet to be made.

ANDERSON RIVER, MACKENZIE. A survey of this river and adjacent lakes from a point 150 miles upstream to its mouth on the arctic coast was carried out. Whitefish, lake herring (cisco), pike and inconnu were the principal species caught, with the largest catches near the river mouth.

BANKS ISLAND, FRANKLIN. A brief survey of streams and lakes of the southwest part of the island produced catches of arctic char, whitefish and lake trout.

ARCTIC CHAR FISHERY, FROBISHER BAY. A small commercial char fishery begun in 1958 by the Department of Northern Affairs and National Resources on the Sylvia Grinnell River at the head of Frobisher Bay led to a special study of the stocks in relation to the fishery.

About 40,000 lb of char were taken from the river in 1958. Of this amount, 27,000 lb came from a local sport fishery and an Eskimo catch. The remainder

was taken by the commercial fishery and our own research project. No other fishes except sticklebacks are in this water system.

While there is still some doubt as to the true picture of maturity in arctic char, three stages of maturity, particularly evident in females, suggest that spawning occurs only every third year. This confirms earlier conclusions from a 1950 investigation.

A fairly complete analysis of all data has indicated that a rate of fishing mortality of about 20% of the stock, producing a sustained catch of about 45,000 lb annually, is possible.

This relatively low sustained yield indicates that any development of organized char fishing in the Arctic should take the form of numbers of small efforts spread over a number of rivers.

LAKE STUDIES OF CHAR, FROBISHER BAY. Sampling of fish was done on several lakes, including Sylvia Grinnell, the main lake feeding the Sylvia Grinnell River, and several smaller lakes in Frobisher Bay, both with and without access for char to and from the sea. These collections illustrate two sharply distinct main types of char: large anadromous or sea-run fish with few or no parasites, maturing at about 13 years of age, and smaller "land-locked" or lake-resident fish with heavy parasitism, maturing at 6-7 years of age. Populations of both types were discovered together in lakes with access to the sea.

Winter sampling of Sylvia Grinnell Lake suggested that spawning takes place no later than September or October in both anadromous and "lake" fish.

The char studies are turning up widely different ecological types even within the same body of water, and strengthen the view that *Salvelinus alpinus* is a polytypic species.

LAKE HAZEN, ELLESMERE ISLAND. Arctic char collections were made at Lake Hazen, Ellesmere Island, during a general limnological study of the lake as part of Canada's participation in the International Geophysical Year program there. The substantial population of arctic char in this lake is the most northerly one yet studied. About 540 specimens were examined in detail. Full analysis of the data is not completed, but it is apparent that the lake could produce enough fish for human food and dog teams for future similar scale operations in the area.

Primary production in the lake, though very low as might be expected, began in mid-June before the melt season had begun, under 5 feet of ice and 1 foot of snow. The zooplankton collections have been sent to experts for analysis, as well as chironomid larvae which formed almost all of the benthos.

Two bottom cores from a small lake adjacent to Hazen are considered to incorporate the entire sedimentary history of the lake, and have been sent to Yale University for biostratigraphic analysis.

TUKTOYAKTUK, MACKENZIE. True herring (*Clupea*) was the principal species taken here. Collections were made to support a detailed taxonomic study and comparison with Atlantic and Pacific forms. One pink salmon (*Oncorhynchus gorbuscha*) in nuptial condition was taken on September 7. A few true (Pacific) salmon are taken regularly in the area of Mackenzie River to Tuktoyaktuk. Their

spawning migration takes place at approximately the same time as it does on the Pacific coast.

MARINE MAMMAL INVESTIGATIONS

Air transport complications prevented a planned continuation of walrus studies in Foxe Basin from being carried out. Active field work on marine mammals was confined to observations during the trip of the *Calanus* from Foxe Basin to Moosonee, Ont., and to an aerial photographic survey of whelping harp seals in the Gulf of St. Lawrence and off the east coast of Labrador and Newfoundland. Considerable progress was made in writing up analyses of marine mammal material and data for publication.

PILOT WHALES IN NEWFOUNDLAND. The fishery for pilot whales in eastern Newfoundland was a comparative failure in 1958, only 781 being taken. Inshore sightings of the whales were extremely few, but they were of normal frequency in deep water areas. The very poor squid catch in Newfoundland in 1958 led to the scarcity of pilot whales which feed almost entirely on squid.

AERIAL PHOTOGRAPHIC SURVEY OF HARP SEALS. Following surveys in 1950, 1951 and 1955, another attempt was made to get complete photographic coverage of the total whelping stock of harp seals on the Canadian east coast. Continued difficulties were encountered in getting thorough coverage of the patches east of Newfoundland at or after the peak of whelping and before the ships break up the patches. This year one major whelping patch was discovered by the industry unusually late (March 21) and after termination of our survey. Applying the known densities of surveyed patches to the information given by the industry gives an estimate of pup production of about 425,000, which would not indicate serious reduction of stock size over the last 8 years, since the last estimate for 1950 and 1951 was about 430,000. However this figure cannot be given with confidence of accuracy at the present time.

In the Gulf of St. Lawrence, thorough coverage of the patches up to March 9 indicated an adult population, believed mainly adult females, on the ice at that time of about 150,000, with whelping still not complete. Previous estimates of pup production were in the order of 215,000 for the gulf.

SURVIVAL OF HARP SEAL AGE CLASSES. Continued surveillance of the age composition of the stocks strengthens the view previously put forward that a kill of the order of 250,000 or more young seals by the ships leads to a low survival rate as compared with years of catches of the order of 180,000 or less. This has occurred in two recent years, 1951 (265,000 young killed) and 1956 (302,000 young killed).

STATUS OF THE HARBOUR SEAL IN THE EASTERN ARCTIC. A review of current data corrects a misconception that this species is a summer migrant into the Arctic. As in more southern regions, it is a local year-round resident where conditions are suitable. An examination from the taxonomic point of view of material on hand suggests caution in viewing an Ungava lake form, which has been described as an isolated subspecies, as being indeed isolated.

WALRUS STUDIES. The age composition of a random sample of males from Foxe Basin suggests that the male stock, which is the chief target of hunters, is well but not excessively utilized, since about 15% of the sample was of males over 20 years of age.

A second random sample from Resolute, on Cornwallis Island in the archipelago, shows a stronger proportion of older animals, in agreement with the fact that stocks of Lancaster Sound are little utilized.

A third sample from Southampton Island was selected for the larger animals, but still suggests that this population at present is not over-exploited.

MARINE MAMMAL AGEING STUDIES. Continued efforts to discover and improve ageing techniques resulted in confirmation of our scale of age-reading for delphinids through studying the structure of teeth of dolphins of known or partly known age from the Marineland Research Laboratory in Florida. In Canada, the method, for delphinids, is applied particularly to the pilot whale and white whale or beluga. Through the cooperation of the United States Fish and Wildlife Service in Seattle, Washington, the tooth of a known age (19½ years) harbour seal from the Seattle Zoo gave complete correlation between the number of cementum layers and the age in years. Apparently this is the first occasion when the tooth-structure ageing technique has been confirmed by sure knowledge of the age of a phocid seal.

BIOLOGICAL OCEANOGRAPHY

EASTERN HUDSON BAY. Although the M.V. *Calanus* was freed from her Rowley Island beach site of the last year and a half, uncertain ice conditions made it prudent to concentrate on getting the ship to a southern wintering site, so that no program was carried out in Foxe Basin. During the trip to Moosonee at the southern end of James Bay, stations were occupied, in September, between Hudson Strait and James Bay, along the east coast of Hudson Bay. Eastern Hudson Bay was found to be distinctly less saline, in all but the deepest waters, than northern Hudson Bay. The data are supplemented by others obtained by a shore-based party on the Belcher Islands in June and July. Zooplankton was relatively sparse in the shallow water sampled (usually less than 50 metres), where water temperatures were usually above zero Centigrade and salinity ranged from 26.5‰ to less than 29.0‰. From the vessel in September, richer hauls were made from below 50 metres in water of below-zero temperature and more than 29‰ salinity. The benthos showed greater variety in deeper, colder and more saline waters than in the shallower areas. Apparently low salinity is a limiting factor for plankton and benthos in southeastern Hudson Bay generally.

INVERTEBRATE STUDIES. Efforts being made to treat all collections made by the *Calanus* programs include turning over certain groups to qualified outside experts interested in the material. Such material includes the pelecypod molluscs, benthonic amphipods, and freshwater plankton. Analysis of material on the edible mussel (*Mytilus edulis*) was analyzed and published in this way in 1958.

At the Unit, a monograph on Canadian arctic asteroids (starfishes) is in preparation, including a key to species, and data on morphological variation, bathymetric distribution, bottom type, temperature and geographical distribution. A shorter work on alcyonarians (soft corals) was completed. A report on zooplankton in relation to the annual oceanographic cycle at Igloolik, Franklin, was completed. Reviews of hydrographic data collected by the *Calanus*, and of basic production in northern waters were published.

Work is continuing on zooplankton collected in Foxe Basin between 1955 and 1957 by the *Calanus* and H.M.C.S. *Labrador*.

PHYTOPLANKTON STUDIES. Taxonomic studies of the dinoflagellates, with an illustrated monograph as an objective, were continued. Progress was made on publication of smaller detailed studies of this group. Major attention at present is focused on quantitative estimates of phytoplankton production from stations made in 1956 by the *Calanus* and *Labrador* in Foxe Basin, Fury and Hecla Strait, Gulf of Boothia, Prince Regent Inlet, Lancaster Sound, Baffin Bay, Davis Strait and Hudson Strait. Striking differences in phytoplankton types relative to hydrographic differences are evident, and areas of greater productivity are being distinguished from those where production is a minimum.

